CHM 129
Problem Set #12

1 (a) $q = +850\,J$ $\quad w = -382\,J$

$\Delta E = q + w = 850J + (-382J) = 468\,J$

Endothermic process because heat (q) is absorbed (+).

(b) $q = -255\,J$ $\quad w = -P\Delta V = -(1.1\,atm)(3.5\,L - 0.5\,L)$

$= -3.3\,L\cdot atm\left(\frac{101.3\,J}{1\,L\cdot atm}\right) = -334\,J$

$\Delta E = q + w = -255\,J + (-334\,J) = -589\,J$

Exothermic process because heat (q) is released (−).

(c) $q = -6.47\,kJ$ $\quad w = 0$

$\Delta E = q + w = -6.47\,kJ + 0 = -6.47\,kJ$

Exothermic process because heat (q) is released (−).

2 (a) When a process occurs under constant external pressure, the enthalpy change (ΔH) equals the amount of heat transferred. $\Delta H = q_p$

(b) $\Delta H = q_p$. If the system absorbs heat, q and ΔH are positive and the enthalpy of the system increases.

3 (a) $0.200\,mol\,AgCl\left(\frac{-65.5\,kJ}{1\,mol\,AgCl}\right) = -13.1\,kJ$

(b) $AgCl_{(s)} \longrightarrow Ag^+_{(aq)} + Cl^-_{(aq)}$ $\quad \Delta H = +65.5\,kJ$

$0.150\,mmol\left(\frac{10^{-3}\,mol}{1\,mmol}\right)\left(\frac{+65.5\,kJ}{1\,mol\,AgCl}\right) = 9.83\times10^{-3}\,kJ = 9.83\,J$

(4)

$$N_2O \longrightarrow \cancel{N_2} + \tfrac{1}{2}\cancel{O_2} \qquad \Delta H = \tfrac{1}{2}(-163.2\ kJ)$$

$$NO_2 \longrightarrow NO + \tfrac{1}{2}\cancel{O_2} \qquad \Delta H = \tfrac{1}{2}(+113.1\ kJ)$$

$$\cancel{N_2} + \cancel{O_2} \longrightarrow 2\,NO \qquad \Delta H = +180.7\ kJ$$

$$N_2O + NO_2 \longrightarrow 3\,NO$$

$$\Delta H = \left(\tfrac{1}{2} \times -163.2\ kJ\right) + \left(\tfrac{1}{2} \times +113.\ kJ\right) + 180.7\ kJ = +155.7\ kJ$$

(5) (a) $\Delta H_R^\circ = \left[\left(2\,mol \times 0\,\frac{kJ}{mol}\right) + \left(2\,mol \times -285.83\,\frac{kJ}{mol}\right)\right] - \left[\left(4\,mol \times -36.23\,\frac{kJ}{mol}\right) + \left(1\,mol \times 0\,\frac{kJ}{mol}\right)\right] = \underline{-426.74\ kJ}$

(b) $\Delta H_R^\circ = \left[\left(1\,mol \times -1387.1\,\frac{kJ}{mol}\right) + \left(1\,mol \times -241.82\,\frac{kJ}{mol}\right)\right] - \left[\left(2\,mol \times -425.6\,\frac{kJ}{mol}\right) + \left(1\,mol \times -395.2\,\frac{kJ}{mol}\right)\right] = \underline{-382.5\ kJ}$

(c) $\Delta H_R^\circ = \left[\left(1\,mol \times -139.3\,\frac{kJ}{mol}\right) + \left(4\,mol \times -92.30\,\frac{kJ}{mol}\right)\right] - \left[\left(1\,mol \times -74.8\,\frac{kJ}{mol}\right) + \left(4\,mol \times 0\,\frac{kJ}{mol}\right)\right] = \underline{-433.7\ kJ}$

(d) $\Delta H_R^\circ = \left[\left(3\,mol \times -241.82\,\frac{kJ}{mol}\right) + \left(2\,mol \times -460\,\frac{kJ}{mol}\right)\right] - \left[\left(1\,mol \times -822.16\,\frac{kJ}{mol}\right) + \left(6\,mol \times -92.30\,\frac{kJ}{mol}\right)\right] = \underline{-150\ kJ}$

(6) (a) Both beakers of water contain the same mass of water, so they both have the same heat capacity. Object A raises the temperature of its water more than object B, so more heat was transferred from object A than B. Since both objects were heated to the same temperature initially, object A most have absorbed more heat to reach 100°. The greater the heat capacity of an object, the greater the heat required to produce a given rise in temperature. Thus, object A has the greater heat capacity.

(b) Since no information about the masses of the objects is given, we cannot compare the specific heats of the objects.

7 $q = mC_s \Delta T = (62.0 g)(2.42 \frac{J}{g \cdot °C})(40.5°C - 13.1°C)$

$q = 4{,}110 J$

8 (a) $q = -m_{soln} C_s \Delta T = \Delta H$ (@ constant pressure)

$q = -(60.0 g + 3.88 g)(4.184 \frac{J}{°C \cdot g})(18.4°C - 23.0°C)$

$q = +1{,}229 J = 1{,}200 J$

$3.88 g \left(\frac{1 mol}{80.06 g}\right) =$

$\Delta H = \frac{1{,}229 J}{0.0484 mol}\left(\frac{1 kJ}{1000 J}\right) = 25 \frac{kJ}{mol}$

(b) ΔH is positive ⇒ heat is absorbed Endothermic Process

9 (a) $C_6H_5OH + 7O_2 \longrightarrow 6CO_2 + 3H_2O$

(b) $q_{Rx} = -C_{cal} \times \Delta T$

$= -(11.66 kJ/°C)(26.37°C - 21.36°C)$

$q_{Rx} = -58.4 kJ$

Per gram $= \frac{-58.4 kJ}{1.800 g} = -32.5 \frac{kJ}{g}$

Per mole : $\frac{-58.4 kJ}{0.01912 mol} = -3{,}050 kJ/mol$

mole $= 1.800 g \left(\frac{1 mol}{94.12 g}\right) = 0.01912 mol$